AMENDMENTS TO THE CLAIMS

1. (Original) A method of determining characteristics of an anisotropic earth formation, the method comprising:

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transmitting acoustic energy into the earth formation, and wherein the earth formation breaks the acoustic energy into a fast polarization shear wave and a slow polarization shear wave;

receiving composite waveforms comprising components of both the fast and slow polarization shear waves;

decomposing the composite waveforms into decomposed waveforms;

estimating source waveforms from the decomposed waveforms to create estimated source waveforms; and

comparing the estimated source waveforms to determine characteristics of the anisotropic earth formation.

2. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 1 wherein transmitting acoustic energy into the earth formation further comprises:

firing a first dipole transmitter in a first axial direction; then

firing a second dipole transmitter in an axial direction substantially azimuthaly perpendicular to the first axial direction.

3. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 2 wherein receiving composite waveforms comprising components of both the fast and slow polarization shear waves further comprises:

receiving a first set of composite waveforms with a first dipole receiver pair associated with the firing of the first dipole transmitter;

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receiving a second set of composite waveforms with a second dipole receiver pair associated with the firing of the first dipole transmitter;

receiving a third set of composite waveforms with the first dipole receiver pair associated with the firing of the second dipole transmitter; and

receiving a fourth set of composite waveforms with the second dipole receiver pair associated with the firing of the second dipole transmitter.

4. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 3 wherein decomposing the composite waveforms into decomposed waveforms further comprises:

estimating a transfer function of the anisotropic earth formation comprising at least a strike angle for the anisotropy and an acoustic velocity;

decomposing the first and third set of composite waveforms using the strike angle to create a first decomposed waveform;

decomposing the second and fourth composite waveforms to create a second decomposed waveform; and

applying the inverse of the estimated transfer function to the decomposed waveforms to create the estimated source waveforms.

5. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 1 wherein comparing the estimated source waveforms to determine the characteristic of the anisotropic earth formation further comprises:

calculating an objective function based on the estimated source waveforms; and

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determining the characteristic of the anisotropic earth formation based on a plot containing the objective function.

6. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 5 wherein calculating an objective function based on the estimated source waveforms further comprises:

averaging the estimated source waveforms to determine an average estimated source waveform; and

determining a variance value of the estimated source waveforms using the average estimated source waveform, the variance value being the objective function.

7. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 6 wherein averaging the estimated source waveforms to determine an average estimated source waveform further comprises determining the average estimated source waveform using substantially the following equation:

$$S_{EST_{AVG}}(t) = \frac{1}{N}\sum_{i=1}^{N} S_{EST_i}(t)$$

where $S_{EST_{AVG}}$ is the average estimated source waveform, N is the number of decomposed waveforms used to create the average estimated source signal, S_{EST_i} is the estimated source waveform for each decomposed waveform, and t is time.

8. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 6 wherein determining a variance value of the estimated source waveforms using the average estimated source waveform further comprises:

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$$\delta^2 = \sum_{i=1}^{N} (S_{EST_i}(t) - S_{EST_{AVG}}(t))^2$$

where δ^2 is the variance, $S_{EST_{AVG}}$ is the average estimated source waveform, N is the number of decomposed waveforms used to create the average estimated source signal, S_{EST_i} is the estimated source waveform for each decomposed waveform, and t is time.

9. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 6 further comprising:

plotting multiple variance values calculated for multiple sets of estimated source waveforms; and

determining inflection points of the variance values within the plot as indicative of acoustic velocity within the earth formation.

10. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 9 wherein comparing the estimated source waveforms to determine the acoustic velocity further comprises finding locations where the inflection points are minimas.

11. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 10 further comprising estimating an error in the determination of the characteristic of the anisotropic earth formation based on a value of the objective function at the minimas.

12. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 10 further comprising estimating an error in the determination of the characteristic of the anisotropic earth formation based on a curvature of the plot of the value of the objective function at the minimas.

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13. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 1 wherein comparing the estimated source waveforms to determine the acoustic velocity further comprises:

calculating a differences between each estimated source waveforms to obtain an objective function using substantially the following equation

$$\zeta = \sum_{i=1}^{N-1} (S_{EST_{i+1}} - S_{EST_i})^2$$

where ζ is the objective function, and N is the number of decomposed waveforms, and S_{EST_i} is the estimated source waveform for each decomposed waveform.

14. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 13 wherein comparing the estimated source waveforms to determine the acoustic velocity further comprises:

plotting multiple values of the objective function calculated for multiple sets of estimated source waveforms; and

determining inflection points of the values of the objective function within the plot as indicative of acoustic velocity within the earth formation.

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15. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 14 wherein comparing the estimated source waveforms to determine the acoustic velocity further comprises finding locations where the inflection points are minimas.

16. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 15 wherein an error in the determination of the acoustic velocity is proportional to the a curvature of the values of the objective function at the minimas.

17. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 1 wherein comparing the estimated source waveforms to determine characteristics of the anisotropic earth formation further comprises comparing the estimated source waveforms to determine at least one of the fast and slow polarization shear wave acoustic velocities.

18. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 1 wherein comparing the estimated source waveforms to determine characteristics of the anisotropic earth formation further comprises comparing the estimated source waveforms to determine a strike angle of the anisotropy.

19. (Original) The method of determining characteristics of an anisotropic earth formation as defined in claim 18 further comprising determining an error estimate of the strike angle by comparing an angle between the fast and slow polarization shear waves.

20-29. (Withdrawn)

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30. (Original) In an anisotropic earth formation where an induced shear wave breaks up into a fast polarization component and a slow polarization component, a method of determining characteristics of the earth formation comprising:

a) generating acoustic signals with dipole transmitter pair by firing a first dipole transmitter, then firing a second dipole transmitter;

b) receiving at a first dipole receiver pair acoustic energy composite signals containing information about both the fast and slow polarization components;

c) receiving at a second dipole receiver pair acoustic energy composite signals containing information about both the fast and slow polarization components;

d) decomposing the signals of the first dipole receiver pair into a first decomposed signal for a strike angle;

e) decomposing the signals of the second dipole receiver pair into a second decomposed signal for the strike angle;

f) estimating a an assumed slowness of the earth formation;

g) estimating a first source wavelet based on the first decomposed signal;

h) estimating a second source wavelet based on the second decomposed signal;

i) comparing the first and second source wavelets to obtain an objective function;

j) plotting the objecting function as a function of slowness of the assumed transfer function, a start time within the decomposed signals, and strike angle;

k) repeating steps f) through j) for a plurality of assumed transfer functions;

l) repeating steps f) through k) for a plurality of start times within the decomposed signal; and

m) repeating steps d) through l) for a plurality of strike angles.

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31. (Original) The method of determining characteristics of an earth formation as defined in claim 30 wherein decomposing the signals of the first dipole receiver pair into a first decomposed signal further comprises calculating the first decomposed signal using substantially the following equation:

$$DS(t) = \cos^2(\theta)\, R_{XX}(t) + \sin(\theta)\cos(\theta)\, [R_{XY}(t)+R_{YX}(t)] + \sin^2(\theta)\, R_{YY}(t)$$

where DS(t) is the decomposed signal, θ is the strike angle, R_{XX} is a signal received by a first receiver of the first receiver pair with an axis oriented in an X direction when a transmitter in the X direction is fired, R_{XY} is a signal received by the first receiver of the first receiver pair when a transmitter in a transmitter in the Y direction is fired, R_{YX} is a signal received by a second receiver of the first receiver pair with an axis oriented in the Y direction when the transmitter oriented in the X direction is fired, and R_{YY} is a signal received by the second receiver oriented in the Y direction when the transmitter oriented in the Y direction is fired.

32. (Original) The method of determining characteristics of an earth formation as defined in claim 30 wherein decomposing the signals of the second dipole receiver pair into a second decomposed signal further comprises calculating the first decomposed signal using substantially the following equation:

$$DS(t) = \cos^2(\theta)\, R_{XX}(t) + \sin(\theta)\cos(\theta)\, [R_{XY}(t)+R_{YX}(t)] + \sin^2(\theta)\, R_{YY}(t)$$

where DS(t) is the decomposed signal, θ is the strike angle, R_{XX} is a signal received by a first receiver of the second receiver pair with an axis oriented in an X direction when a transmitter in the X direction is fired, R_{XY} is a signal received by the first receiver of the second receiver pair when a transmitter in a transmitter in the Y direction is fired, R_{YX} is a signal received by a second receiver of the second receiver pair with an axis oriented in the Y direction when the transmitter oriented in

the X direction is fired, and R_{YY} is a signal received by the second receiver oriented in the Y direction when the transmitter oriented in the Y direction is fired.

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33. (Original) The method of determining a characteristic of an earth formation as defined in claim 30 wherein comparing the first and second source wavelets to obtain an objective function further comprises:

calculating an average estimated source wavelet; and

calculating a variance of the estimated source wavelets from the average estimated source wavelet.

34. (Original) The method of determining a characteristic of an earth formation as defined in claim 33 wherein calculating the average estimated source wavelet further comprises calculating the average estimated source wavelet using substantially the following equation:

$$S_{EST_{AVG}}(t) = \frac{1}{N}\sum_{i=1}^{N} S_{EST_i}(t)$$

where $S_{EST_{AVG}}$ is the average estimated source signal, N is the number estimated source wavelets, S_{EST_i} is the estimated source wavelet, and t is time.

35. (Original) The method of determining a characteristic of an earth formation as defined in claim 34 wherein calculating a variance of the estimated source wavelets from the average estimated source wavelet further comprises calculating the variance using substantially the following equation:

$$\delta^2 = \sum_{i=1}^{N}(S_{EST_i}(t) - S_{EST_{AVG}}(t))^2$$

where δ^2 is the variance.

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36. (Original) The method of determining a characteristic of an earth formation as defined in claim 30 wherein comparing the first and second source wavelets to obtain an objective function further comprises determining a difference between the estimated source wavelets as the objective function.

37. (Original) The method of determining a characteristic of an earth formation as defined in claim 36 wherein determining a difference between the estimated source wavelets further comprises calculating an objective function using substantially the following equation:

$$\zeta = \sum_{i=1}^{N-1} (S_{EST_{i+1}} - S_{EST_i})^2$$

where ζ is the objective function, S_{EST_i} is the estimated source wavelet, and N is the number of estimated source wavelets.

38-57 (Withdrawn)